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ANNULAR ECLIPSE OF SEPTEMBER 1, 1951

PATH OF ANNULAR PHASE IN THE UNITED STATES

This Circular, prepared under the supervision of Isabel M. Lewis, is chiefly for the use of those who plan to make scientific observations of the eclipse of September 1, 1951, within that part of the path of the annular phase which lies in the United States. The path has an extent of about 280 miles from the point where the axis of the shadow-cone first touches the earth in the Blue Ridge Mountains near Dobson, N. C. to the point midway between Cape Charles and Cape Henry where it passes into the Atlantic Ocean. Its width is about 95 miles.

The altitude of the *center* of the sun at the time of the middle of the annular phase on the central line increases from zero degrees at the point where the axis of the shadow-cone first touches the earth in latitude $36^{\circ}19'2''N.$, longitude $80^{\circ}55'7''W.$, to about four degrees where it passes into the Atlantic Ocean.

The times in the first column of the table on Page 3 are the Universal Times of the middle of the annular phase for the geographical positions given. When these times are compared with the times of sunrise for the same positions it must be kept in mind that sunrise as usually defined occurs when the upper limb of the sun corrected for the effect of refraction is on the horizon. Upon comparing the time of sunrise at the limiting position, Page 3, first line, with the middle of the annular phase at the same point it is found that the sun rises about four minutes before the middle of the annular phase occurs. When the axis has reached a point defined by the last position on Page 3, the middle of the annular phase will occur about 26 minutes after sunrise.

The combined effect of refraction and elevation upon the times of the beginning and ending of the annular phase has been taken into account in the calculation of the local circumstances for 20 towns within this region. The positions and elevations adopted for these towns are given on Page 4.

The times and position angles for second, third, and fourth contacts, or beginning and ending of the annular phase and ending of the eclipse, are given on Page 5. The beginning of the eclipse, or first contact, occurs at all places in this region with the sun below the horizon, and the sun rises more or less partially eclipsed.

The magnitude of the annular phase is nearly constant at all points within the path. Its value is 0.96 in units of the sun's diameter; that is 0.96 is the part of the sun's diameter covered by the moon during the annular phase.

In the western part of the path, in the Blue Ridge Mountains, where the elevation of the sun at the middle of the annular phase is less than one degree and where there are numerous peaks from 2000 ft. to more than 3000 ft. high, the combined effect of refraction and elevation of the observer above sea-level is quite appreciable, affecting the times of beginning and ending of the annular phase by as much as 2 or 3 seconds. The altitude effect becomes negligible on passing from the central plateau region into the tide-water section of North Carolina and Virginia. The most favorable location for observing the eclipse should be in the general vicinity of Norfolk, Va.

The map on Page 7 shows the position of the central line, or path of the axis of the shadow-cone, and the northern and southern limits of the path, together with the lines connecting all places where the eclipse ends at the Universal Times indicated. This map is a small section taken from the eastern half of the large scale map of the United States published by the United States Geological Survey with projection and shore lines by the United States Coast and Geodetic Survey (Edition of 1932, reprinted 1950). The scale is approximately 40 miles to the inch. The positions of the towns for which local circumstances have been calculated do not in every instance agree exactly with the positions shown on this chart, as they have been taken from a different source; see Page 4 for the positions used in the calculations. The effect of refraction, and the elevation of the observer when appreciable, are included in the geocentric coordinates.

On Page 6 are given ionospheric data for selected places outside this region which had previously been prepared for special purposes and are included here because of their possible wider usefulness.

The local circumstances of this eclipse for a number of places in the United States that are not within the path of the annular phase, also information regarding the elements and circumstances of the eclipse in general, with a chart covering the entire eclipse region and an example of the calculation of the circumstances of the eclipse for a chosen site, will be found in the *American Ephemeris and Nautical Almanac* for 1951, Pages 342, 346-348, 350-351, 597-605; see also Page VIII for the corrections applied to the positions of the Sun and Moon.

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Universal Time	Central Line Latitude Longitude		Half Width of Path	Altitude of Sun	Duration of Annular Phase on Central Line
h m s	° '	° '	Miles	°	Seconds
10 58 41.4 (Limit)	+36 19.2	+80 55.7	----	0.0	----
10 58 41.6	+36 24.2	+80 22.0	47.9	0.4	159.3
58 41.8	36 26.2	80 9.4	47.8	0.6	159.3
58 42.0	36 27.5	79 59.4	47.7	0.8	159.4
58 43.0	36 32.4	79 25.0	47.6	1.2	159.4
58 44.0	36 35.8	79 0.8	47.4	1.6	159.5
10 58 45.0	+36 38.6	+78 40.6	47.3	1.9	159.5
58 46.0	36 41.0	78 23.1	47.2	2.1	159.5
58 47.0	36 43.1	78 7.4	47.2	2.3	159.6
58 48.0	36 45.0	77 53.3	47.1	2.5	159.6
58 49.0	36 46.7	77 40.0	47.1	2.7	159.7
10 58 50.0	+36 48.3	+77 27.6	47.0	2.9	159.7
58 51.0	36 49.8	77 16.0	46.9	3.0	159.7
58 52.0	36 51.2	77 4.8	46.9	3.2	159.7
58 53.0	36 52.6	76 54.3	46.8	3.3	159.8
58 54.0	36 53.8	76 44.2	46.7	3.5	159.8
10 58 55.0	+36 55.0	+76 34.4	46.7	3.6	159.8
58 56.0	36 56.2	76 25.1	46.6	3.7	159.8
58 57.0	36 57.3	76 16.1	46.6	3.8	159.8
58 58.0	36 58.3	76 7.3	46.6	4.0	159.8
10 58 59.0	+36 59.4	+75 58.8	46.5	4.1	159.9

Column 1 gives the Universal Time when the axis of the shadow-cone intersects the earth's surface at the geographical positions in columns 2 and 3; it is the time of the middle of the annular phase at these points. To find the times of beginning and ending of the annular phase at each point subtract from and add to the time of the middle of the annular phase half of the duration of the annular phase given in column 6.

Column 4 gives the half width of path by means of which the positions of the northern and southern limits of the path may be found. It is the shortest distance in miles from the points on the central line to the limits of the path.

The altitude of the sun given in column 5 is that of the center of the solar disk uncorrected for refraction and the elevation of the observer above sea-level.

ANNULAR ECLIPSE OF SEPTEMBER 1, 1951
POSITIONS OF TWENTY TOWNS IN PATH OF ANNULAR PHASE

Place	Latitude		Longitude		Elevation* feet	Geocentric Co-ordinates†	
	o	'	o	'		$\rho \sin \varphi'$	$\rho \cos \varphi'$
Winston-Salem, N. C.	+36	5	+80	15	860	0.585831	0.809308
Hillsville, Va.	36	43	80	45	2570	0.594756	0.802840
Greensboro, N. C.	36	4	79	46	840	0.585569	0.809438
Martinsville, Va.	36	42	79	54	1025	0.594443	0.802905
Danville, Va.	+36	35	+79	21	410	0.592781	0.804072
Roxboro, N. C.	36	23	78	58	650	0.589984	0.806143
Durham, N. C.	36	0	78	55	405	0.584594	0.810070
Henderson, N. C.	36	18	78	22	505	0.588799	0.806977
Lawrenceville, Va.	+36	46	+77	52	----	0.595297	0.802108
Emporia, Va.	36	41	77	33	----	0.594134	0.802972
Petersburg, Va.	37	12	77	24	----	0.601314	0.797562
Suffolk, Va.	36	40	76	35	----	0.593890	0.803130
Williamsburg, Va.	+37	15	+76	40	----	0.601999	0.797025
Yorktown, Va.	37	12	76	32	----	0.601306	0.797550
Hampton, Va.	37	0	76	22	----	0.598529	0.799650
Newport News, Va.	36	57	76	26	----	0.597834	0.800173
Norfolk, Va.	+36	50	+76	18	----	0.596209	0.801390
Portsmouth, Va.	36	47	76	20	----	0.595514	0.801912
Virginia Beach, Va.	36	51	75	59	----	0.596439	0.801213
Cape Charles, Va. (Ry.)	37	17	76	2	----	0.602456	0.796669

*If the elevation of the place above sea-level is less than 400 feet no correction to the geocentric co-ordinates for the effect of elevation has been made.

†The effect of refraction on the geocentric co-ordinates of the place has been calculated from the table in Chauvenet's *Spherical and Practical Astronomy*, Vol. I, Page 517. The altitude of the sun at the middle of the annular phase was used to obtain the argument of this table.

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LOCAL CIRCUMSTANCES FOR TOWNS IN PATH OF ANNULAR PHASE

UNIVERSAL TIME OR GREENWICH CIVIL TIME

Place	Second Contact	P	V	Third Contact	P	V	Fourth Contact	P	V
Winston-Salem, N. C.	10 ^h 57 ^m 21 ^s	322°	16°	10 ^h 59 ^m 42 ^s	85°	139°	12 ^h 4 ^m 56 ^s	114°	169°
Hillsville, Va.	10 57 41	260	313	10 59 57	145	198	12 5 0	116	170
Greensboro, N. C.	10 57 26	331	25	10 59 34	77	131	12 5 8	114	169
Martinsville, Va.	10 57 32	274	328	11 0 2	133	186	12 5 19	116	170
Danville, Va.	10 57 23	291	344	11 0 3	117	170	12 5 31	115	170
Roxboro, N. C.	10 57 21	312	6	10 59 53	96	149	12 5 37	115	169
Durham, N. C.	10 57 48	356	50	10 59 6	52	106	12 5 29	114	169
Henderson, N. C.	10 57 28	328	22	10 59 42	80	134	12 5 52	115	169
Lawrenceville, Va.	10 57 28	293	346	11 0 8	115	169	12 6 16	116	170
Emporia, Va.	10 57 27	303	357	11 0 5	105	159	12 6 24	115	170
Petersburg, Va.	10 57 54	260	313	11 0 6	148	201	12 6 40	116	170
Suffolk, Va.	10 57 33	316	9	11 0 2	93	147	12 6 54	115	170
Williamsburg, Va.	10 57 54	263	316	11 0 12	145	198	12 7 4	116	170
Yorktown, Va.	10 57 50	270	323	11 0 15	138	191	12 7 7	116	170
Hampton, Va.	10 57 38	289	343	11 0 17	119	173	12 7 8	116	170
Newport News, Va.	10 57 36	293	346	11 0 16	116	169	12 7 5	116	170
Norfolk, Va.	10 57 34	304	358	11 0 12	104	158	12 7 6	116	170
Portsmouth, Va.	10 57 34	308	2	11 0 9	101	154	12 7 4	115	170
Virginia Beach, Va.	10 57 37	306	359	11 0 13	103	156	12 7 17	116	170
Cape Charles, Va.(Ry.)	10 57 55	268	321	11 0 18	141	194	12 7 25	116	170

First contact or the beginning of the partial phase of the eclipse occurs at all places within the path of the annulus in the United States with the Sun below the horizon.

P is the position angle of the point of contact measured from the north point of the Sun's limb eastward through 360°.

V is the position angle of the point of contact measured from the vertex of the Sun's limb eastward through 360°.

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		Magnitude Sun's diam. =1			Greatest Phase	
U. T.	Surface	100 km	200 km	300 km	at surface U. T.	Mag.
Washington, D. C.						
10 ^h 55 ^m	0.884	0.897	0.902	0.898	10 ^h 59 ^m .9	0.919
11 0	0.919	0.906	0.887	0.864		
11 5	0.881	0.855	0.829	0.803		
Charlottesville, Va.						
10 55	0.901	0.917	0.924	0.918	10 59. 4	0.939
11 0	0.938	0.921	0.897	0.872		
11 5	0.885	0.858	0.831	0.804		
Hamilton, Bermuda						
10 55	0.796	0.807	0.815	0.818	11 0. 3	0.811
11 0	0.811	0.812	0.808	0.801		
11 5	0.799	0.790	0.778	0.763		
Halifax, Nova Scotia						
10 55	0.729	0.737	0.742	0.745	11 5. 8	0.781
11 0	0.765	0.766	0.763	0.758		
11 5	0.781	0.773	0.762	0.748		

Note: Amount of Obscured Area of the Solar Surface can be taken from a table, with above data and S, as arguments; see *Astr. Jour.* No. 1122, 'Formulas for Ionosphere Track in Eclipses.'

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